# Prediction of general hospital admission in people with dementia

**Prediction of general hospital admission in people with dementia: cohort study**

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**ABSTRACT**

**Background:** People with dementia are extremely vulnerable in hospital and unscheduled admissions should be avoided, if possible.

**Aims:** To identify any predictors of general hospital admission in people with dementia in a well-characterised national prospective cohort study.

**Methods:** Cohort study of 730 people with dementia drawn from the Scottish Dementia Research Interest Register (47.8% female; mean±standard deviation age 76.3±8.2 years, range 50-94) with a mean follow up of 1.2 years.

**Results:** In the age- and sex-adjusted multivariable model (N=681; 251 admitted), Neuropsychiatric Inventory score (hazard ratio per standard deviation disadvantage; 95% confidence interval: 1.21; 1.08-1.36) was identified as an independent predictor of admission to hospital.

**Conclusions:** Neuropsychiatric symptoms in dementia – measured by the Neuropsychiatric Inventory – predict non-psychiatric hospital admission of people with dementia. Further studies are merited to test whether interventions to reduce such symptoms might reduce unscheduled admissions to acute hospitals.

**Declaration of interest:** none

## INTRODUCTION

Dementia is a major and increasing public health concern. There are currently over 800,000 people with dementia in the UK[1] and approximately 6% of these individuals are estimated to be in hospital at any one time, ten times the rate in older adults without dementia.[2] People with dementia in acute, general hospital wards are extremely vulnerable and suffer from increased mortality[3-5] and other adverse outcomes, including longer length of stay, increased rates of delirium, and new institutionalisation.[6] There is general agreement that unscheduled admissions to hospital should be avoided or prevented in this group, where possible.[7, 8] However, little attention has been paid to what factors, including neuropsychiatric symptoms, might influence a person with dementia's risk of being admitted to hospital, as highlighted by a recent systematic review on the topic.[9] Candidate risk factors include age,[10] gender,[10] function,[11, 12] behaviour, [9, 11, 13] medication use,[11] and comorbidity.[11] Published studies on risk of admission are either based on clinical samples,[10, 12] which limits the generalisation of their findings to the general population, or are limited in size, duration of follow up, or the detail in which participants are characterised at baseline.[11-14] Here we present a prospective cohort study of the association between baseline health, cognitive, and functional status and admission to general hospital in a well-characterised national sample of community-dwelling older adults with dementia from across Scotland.

## METHODS

The Scottish Dementia Research Interest Register (SDRIR)[15] comprises people from a variety of demographic backgrounds who have been diagnosed by a clinician as having dementia or a related cognitive disorder (and carers, who were not included in the present study) and who have consented (or in cases where the person lacked capacity, through his/her legal representative) to the storage of information on demographic, cognitive, functional and behavioural measures and have expressed an interest in being approached for participation in future research studies. At

the time of this study, people had been enrolled from eight areas of Scotland covering 75% of the Scottish population including both urban and rural areas. Additional details of the SDRIR and recruitment to it are available in a published report.[15] Approximately 95% of SDRIR registrants consented to record linkage.

When an individual joins the register they are visited by a clinical studies officer who assesses and records their cognition (Addenbrooke's Clinical Examination – Revised[16] [ACE-R]). Via interview with the carer, function (the Instrumental Activities of Daily Living [IADL] and Personal Self-Maintenance [PSMS] scales[17]), and behaviour (the Neuropsychiatric Inventory including Carer Distress [NPI][18]) are rated. A global assessment of severity (the Clinical Dementia Rating scale [CDR][19]) is completed by interviewing the patient and carer. The ACE-R is scored out of 100 and the forms used allow direct calculation of the Mini-Mental State Examination[20] (MMSE). The IADL and PSMS scales are scored out of eight and six, respectively, with one point awarded for each domain of activity in which the individual can function independently; higher scores indicate greater independence. The NPI was recorded as the product of frequency and severity scores for each domain (ranging from one to 12) with carer distress rated separately.[21] Total NPI and carer distress scores are the sum of scores for all ten domains. The CDR consists of global ratings in six domains or 'boxes' (memory, orientation, judgement/problem solving, community affairs, home and hobbies, and personal care) with a rating of 0 (none), 0.5 (very mild), 1 (mild), 2 (moderate), or 3 (severe) being given for each.[19] Details of any illnesses or conditions which are also present and prescribed medication are also recorded, as are health-related behaviours (including smoking) and the number of carers.

To overcome coding problems associated with initial data entry into SDRIR and to correct obvious misclassifications (primarily "young-onset dementia" and "early dementia"), clinical

diagnoses were independently verified by two clinicians (two of TCR, PJC, and JMS) reviewing the data recorded on the SDRIR with disagreement resolved by discussion or, if necessary, consultation with the third clinician. The medications recorded for each person were scrutinized and individuals prescribed cholinesterase inhibitors or antipsychotics were separately flagged. Additionally, any potentially inappropriate medication for use in older adults was identified according to the updated Beers criteria.[22]

Informed consent for potential data linkage was obtained from all participants at the time of registration on the SDRIR or, if they were incapable of doing so, from their legal representative. Ethical approval for the SDRIR and the data linkage was granted by the Scotland A Research Ethics Committee and the record linkage was approved by the Privacy Advisory Committee of the Information Services Division of NHS National Services Scotland.

Data from consenting registrants on the SDRIR were linked using the unique Community Health Index number with Scottish Morbidity Records 01 and 04 which record all admissions to general and psychiatric hospitals in Scotland, respectively. The date of the admission and all diagnostic codes recorded on admission and discharge were recorded. For the present analysis admission to a general hospital was the outcome of interest; data for individuals admitted to a psychiatric hospital were considered censored at that point. The SDRIR data are held by the Health Informatics Centre (HIC) at the University of Dundee and the anonymised, linked dataset was accessed via and analysed in the HIC safe haven using IBM SPSS Statistics version 21.

We calculated the period of time in calendar days from the date of entry onto the SDRIR until the first admission to a general hospital for any reason. For people who were not admitted to

hospital, data were censored either at 2nd June 2012 or at the date of admission to a psychiatric hospital (N=25), whichever came first. After confirming that the proportional hazards assumption was valid, we used Cox regression models[23] to produce hazard ratios with accompanying 95% confidence intervals for the association between individual baseline covariables and admission to hospital. Covariables examined comprised dementia subtype, the presence of vascular risk factors or comorbidity, having a carer, MMSE, IADL, PSMS, total NPI score, NPI carer distress score, CDR rating, and CDR sum of boxes. Given the possibility that cholinesterase inhibitor use may be associated with reduced risk of entry to nursing home care[24] and the concerns surrounding the use of antipsychotic drugs,[25] these variables were also included, as was being prescribed a potentially inappropriate medication. For the present analyses continuous variables were standardised so that hazard ratios reflect one standard deviation disadvantage, regardless of the original direction of the scale. There was no effect modification by gender and therefore data for men and women were pooled. All models included age and sex as these were thought to be of importance a priori.

Next, having considered bivariate associations, we note that some variables are moderately correlated (for example, cognition and activities of daily living). Since we wished to include the key independent variables predicting hospital admission we constructed a multivariable model using forward stepwise entry.

A recent systematic review[9] suggested that the NPI might be important in predicting admission to hospital and so a number of sensitivity analyses examining this association in more detail were carried out: first, we classified total NPI score into three categories (based on published recommended thresholds[26]) in order to examine the shape of the relationship between NPI and hospital admission; second, we investigated the association between individual items and

admission to hospital. Finally, individuals with complete data for all variables were compared with individuals with missing data for one or more variable. Missing data were accounted for by repeating the multivariable model using five multiply imputed datasets.

## RESULTS

From an initial sample of 762 we excluded 26 individuals with mild cognitive impairment and six individuals with data errors (e.g. duplicated records, missing identifiers, or impossible dates of birth) giving an analytic sample of 730 (47.8% female; mean±SD age 76.3±8.2 years, range 50-94). Figure 1 summarises the derivation of the analytic sample. During a mean±SD follow up of 1.2±0.8 years (range 2 days to 3.3 years), 274 (37.5%) of the 730 SDRIR registrants were admitted to a general hospital for any reason. Supplementary Table 1 summarises the number of people who had various common conditions mentioned in their records on discharge from hospital, including falls or collapse (15.3%), ischaemic heart disease (10.6%), and urinary tract infection (10.2%). Out of 274 admissions, 146 (53.3%) had dementia correctly recorded on discharge, although six of these were recorded as having mild cognitive disorder (ICD-10 code F06.7). In contrast, all of the 25 individuals admitted to a psychiatric hospital (not included as admissions in the current analyses) had dementia correctly recorded on their discharge documentation.

Baseline characteristics of the sample are shown in Table 1, stratified into those who were admitted to hospital and those who were not. Just under half of the participants were female, the majority had mild-to-moderate dementia at baseline, and the mean age was in the mid-70s for both groups, though the range spanned several decades. Approximately 80% had AD or mixed dementia and about three quarters were treated with a cholinesterase inhibitor.

*Bivariate analyses*

Men were more likely to be admitted to hospital than women (hazard ratio [HR]; 95% confidence interval [CI]: 1.32; 1.04, 1.68; P=0.022) but age was not associated with admission rates at conventional levels of statistical significance (HR per five years older; 95% CI: 1.07; 0.99, 1.16; P=0.07). Table 2 shows the association between other baseline covariables and subsequent admission to hospital (age- and sex-adjusted HR and 95% CI). There was no increased risk of admission for any diagnostic subtype, apart from the category of 'other dementia,' incorporating dementia with Lewy bodies, Parkinson's disease dementia, fronto-temporal lobar degeneration, and "other dementia, not specified". The suggestion that people with non-AD, non-vascular dementia subtypes might be more likely to be admitted to hospital due to a higher frequency of neuropsychiatric symptoms in those conditions was explored in a Cox model incorporating age and sex with total NPI score and diagnostic grouping selected by forward conditional stepwise entry. Total NPI score remained in the model (HR per SD disadvantage; 95% CI: 1.22; 1.09, 1.37; P<0.001) but having a diagnosis of 'other' dementia was not statistically significant at conventional levels in this model.

There were no statistically significant associations between individual vascular risk factors (hypertension, hypercholesterolaemia, diabetes, or smoking) or individual comorbidities (including cancer, respiratory disease, and diabetes) and so these were separately pooled into composite variables for reporting in Table 2. Vascular risk factors were not associated with future admission to hospital but having any comorbidity was (HR; 95% CI: 1.28; 1.00, 1.65; P=0.05). None of the three medication variables investigated – cholinesterase inhibitors, antipsychotics, and potentially inappropriate medications –were associated with an increased risk of hospital admission.

Baseline cognition was not associated with admission to hospital nor was impaired functional ability measured by the IADL scale. However, impaired self-care, measured by the PSMS, was associated with an increased risk of admission (HR per SD disadvantage; 95% CI: 1.18; 1.04, 1.33; P=0.01). Total NPI score (1.22; 1.09, 1.37; P<0.001) and the NPI carer distress rating (1.14; 1.02, 1.28; P=0.03) were both associated with an increased risk of admission to hospital. People with more advanced dementia, based on CDR score, were not more likely to be admitted to hospital than people with milder dementia ($P_{trend}$=0.45). The CDR sum of boxes[27] was similarly not statistically significantly associated with hospital admission.

*Multivariable model*

Constructing a multivariable model using forward conditional stepwise entry highlighted NPI score as the only statistically significant independent predictor of admission to hospital (HR per SD disadvantage; 95% CI: 1.21; 1.08, 1.36; P=0.001; based on 251 admissions out of 681 individuals).

*Further analyses*

To examine the association between NPI score and hospital admission in more detail, we divided NPI scores into three groups based on recommended thresholds[26]: those scoring zero (the referent), one to 14, and greater than or equal to 15. There was a dose-response association between increasing NPI score and hospital admission (HR; 95% CI: NPI score 1-14 vs 0 1.29; 0.95, 1.76; NPI score ≥15 vs 0 1.82; 1.30, 2.56; $P_{trend}$=0.002) as shown in Figure 2. Examining individual neuropsychiatric symptoms (NPI items) in a *post-hoc* multivariable model using forward stepwise conditional entry highlighted agitation (HR per SD increase [disadvantage]; 95% CI: 1.28; 1.14, 1.43; P<0.001) as the most important aspect of the NPI in terms of predicting admission to hospital.

Data were missing for one or more variables in 21.1% of the sample (N=154). People with missing data were slightly younger, more likely to be female, less likely to have vascular risk factors but more likely to have a comorbidity of any sort, were more likely to have no carers, and had more severe dementia, according to CDR and MMSE, but scored slightly better on IADL, PSMS, and both scales of the NPI (Supplementary Table 2). Thus individuals with missing data did not uniformly have less favourable levels of risk factors. Using multiple imputation to account for missing data in the multivariable models did not alter our conclusions (HR per SD disadvantage in NPI score; 95% CI: 1.20; 1.07, 1.35; P=0.003; HR 'other dementia'; 95% CI: 1.56; 1.02, 2.40; P=0.043).

## DISCUSSION

The main findings of this study are that total NPI score predicts admission to hospital of people with dementia over a mean of 1.2 years with risk increasing as category of severity rises. Further analyses suggest that agitation is the most important predictor within the NPI scale. Amongst the modifiable factors associated with dementia, bivariate analyses identify a relationship between risk of admission and co-morbidity, carer distress and self-care, but these did not persist in multivariable analyses. The risk of admission was significantly lower in the low and middle category of NPI score than the highest category.

Observing this association gives us little information about the possible mechanism. One could speculate that more neuropsychiatric symptoms at baseline could reflect a higher burden of physical illness at baseline. Alternatively, the exacerbation of these symptoms, when already present, might be a common trigger for a GP to seek admission. Whatever the mechanism, these

symptoms are potentially modifiable and the important question is raised whether modifying them reduces unscheduled hospital admissions.

Neuropsychiatric symptoms are often important predictors of nursing home admission[28] and some consideration of these findings may be helpful. Persistent agitation or aggression early in dementia diagnosis may be associated with subsequent depressive symptoms in caregivers.[29] Furthermore, time-varying measures of caregiver burden fully mediated the relationship between four behavioural disturbances (episodes of combativeness, property destruction, repetitive questions, and reliving the past) and nursing home admission.[30] Caregivers who did not indicate a care recipient's dangerous behaviour initially but did so subsequently (i.e., an 'incident' behaviour problem) were more likely to experience increases in burden ($P<0.0026$).[31] Caregivers who indicated greater emotional stress, a desire to institutionalize the care recipient, and feelings of being 'trapped' in care responsibilities were more likely to admit persons with dementia to nursing homes. However, demographic variables, incontinence, and service use did not consistently predict nursing home admission.[32]

Thus, there are important parallels with factors which influence admission to care homes, particularly as behavioural changes in people with dementia are common and persistent.[33] Our data are in keeping with the hypothesis that persistence of behaviour problems increases risk of home placement breaking down and point to focusing on interventions reducing neuropsychiatric symptoms, especially agitation, which is amongst the most persistent of these problems, as those potentially likely to decrease the risk of a person with dementia being admitted to a general hospital.

People with dementia are frequently admitted to hospital[2] and the issue of people with dementia in the general hospital is an important one[6] and, where possible, unscheduled admissions should be avoided in this patient group.[7, 8] However, it is surprising that, despite growing recognition of the public health importance of dementia, particularly in the setting of the general hospital, just over half of these people with confirmed dementia had their diagnosis correctly recorded on discharge from hospital. Recognising that a patient newly admitted to the general hospital has dementia is vital, perhaps most importantly as these people are at high risk of developing delirium which may be partially preventable, but also because the process of discharge planning should be informed by their diagnosis.[2]

Rarer forms of dementia, including fronto-temporal lobar degeneration, are often associated with more prominent neuropsychiatric symptoms. This group was more likely to be admitted to hospital during follow up in the bivariable models but it seems that it may be the NPI score itself rather than diagnostic group per se which is driving this association. While the mean±SD NPI score was higher in the 'other dementia' category (17.9±17.8 vs 10.9±15.1; P=0.012) the maximum scores were much higher in the AD/mixed/vascular dementia group (105 points vs 61 points). This is confirmed by the result of the Cox regression model including both the 'other' diagnostic category and total NPI score – only total NPI score remained statistically significant at conventional levels.

**Comparison with other literature**

Dementia is associated with an increased risk of hospitalization but relatively few studies have investigated the impact of individual characteristics of people with dementia on their risk of admission.[8] A recent systematic review of risk factors for people with dementia being admitted to hospital including ten studies reported that behavioural disturbance is associated with an

increased risk of admission.[9] The results of the present study echo this and our finding that agitation may be the most important symptom is consistent with the findings reported in this systematic review.

There are relatively few articles in the literature prospectively studying cohorts of people with dementia to identify baseline risk factors for admission to hospital. An American teaching hospital cohort study of 827 men and women with AD found that 66% were hospitalised at least once over a median follow up of 3 years, compared with 41% over a mean 1.2 years in the present study.[10] They identified five independent risk factors: higher comorbidity, previous hospitalization, older age, male sex, and shorter duration of dementia. These are similar to the findings of the present study apart from the effect of age (details of illness duration and previous admission to hospital were not available on the SDRIR) but they did not include measures of neuropsychiatric symptoms or function. The REAL.FR study followed 686 patients with AD from all over France over two years and found that 29% were hospitalized at least once in that period.[11, 13, 14] They identified three independent risk factors for hospitalization: functional impairment, polypharmacy, and greater NPI score.[11] However, they did not present data on antipsychotic or inappropriate medication use within the polypharmacy risk they identified. Another French study following 134 patients with AD from a memory clinic found that 23% were admitted to hospital in the following year.[12] They identified that an inability to bathe independently and lower educational attainment were independent risk factors for admission to hospital, but had very limited data on comorbidities and medication, and a small, unrepresentative sample.

**Strengths and limitations**

This is the largest general population prospective study of risk factors for hospitalisation in dementia resulting in adequate power to detect fairly small effect sizes, including identifying a dose-response association between NPI score and hospital admission. A *post-hoc* power calculation suggests that our sample size is powered to detect hazard ratios of approximately 1.2 with 80% power and a significance level of 0.05. It was possible to follow these individuals up for up to 3.3 years during which period a large number were admitted to acute hospitals. The diagnostic categories are based on clinical diagnoses and were independently verified by two clinicians and so are likely to be robust. Furthermore, as demonstrated by the MMSE scores and CDR, they were at a relatively early stage of their illness at baseline and all were community-resident at baseline so it may not be possible to extrapolate these results to all people diagnosed with dementia. However, the fact that this sample consisted mainly of people with mild-to-moderate dementia does not make the results any less important. The supplementary analysis examining individual NPI items was not specified *a priori*, but the fact that it supports findings from a previous systematic review[9] give us some confidence in this result.

Since the hospital admissions were identified from national surveillance datasets, it is likely that all hospital admissions were identified, that these data are robust, and thus the times to admission or censoring from entry onto the register are accurate. The mean time to admission was 0.8 years and so the symptoms might not have been still present at the time of admission. However, neuropsychiatric symptoms have been shown to be relatively persistent, for example up to 67% for agitation over a period of two years.[34] Comprehensive baseline data were available for participants, collected in a standardised manner by trained, skilled clinical studies officers from the Scottish Dementia Clinical Research Network. Furthermore, item-level data were available, allowing us to examine, for example, individual NPI items.

The findings from the models using multiple imputation were similar to the main results, suggesting that missing data have not had a substantial effect on our conclusions.

**Implications and further research needed**

This study investigated a common and important condition and an important setting – the general hospital. Indeed, people with dementia in the general hospital was one of the main foci of the first Scottish Dementia Strategy.[35] Our data are drawn from across Scotland which avoids any problems with factors affecting hospital admission at a regional level, for example, local policies. While the sample covers much of the country, it is not representative of the general population of people with dementia. Since these individuals are selected by expressing an interest in participating in dementia research, it is likely that they are healthier than the general population of people with dementia. This will affect the generalisability of our findings but it is likely that conclusions drawn from studying this community-based sample can be broadly applied to the wider population of people with dementia.

If we accept our finding that total NPI score predicts acute general hospital admission in people with dementia careful consideration is needed regarding the implications of this. Further research is needed to identify whether these admissions could be avoidable through interventions to treat neuropsychiatric symptoms. If it is the case that interventions to reduce neuropsychiatric symptoms and, thus, NPI score, also reduce admission rates to hospital in this vulnerable group many of the adverse consequences for people with dementia of being in hospital might be avoided. Our results suggest that such interventions should be targeted at individuals with higher levels of neuropsychiatric symptoms (NPI score ≥15). Moreover, because neuropsychiatric symptoms correlate positively with carer strain,[36] interventions that reduce neuropsychiatric

symptoms may shorten admissions since carers under less strain may be more willing to accept discharge back home.

Furthermore, risk stratification tools to predict unplanned hospital admissions,[37] for example those used in NHS England, do not currently incorporate mental health variables. Our results suggest that, at least in people with dementia, these variables may be amongst the most important in predicting unscheduled hospital admissions.

Clinical trials to examine whether a reduction in neuropsychiatric symptoms in people with dementia reduces unscheduled hospital admissions are now warranted. If this proved to be a modifiable risk factor for such admissions, this could have substantial clinical and public health impact.

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**FIGURE 1.** Flow chart of participants from initial pooled sample through to analytic sample showing subsequent admission to hospital: longitudinal analysis of 730 men and women from the Scottish Dementia Research Interest Register

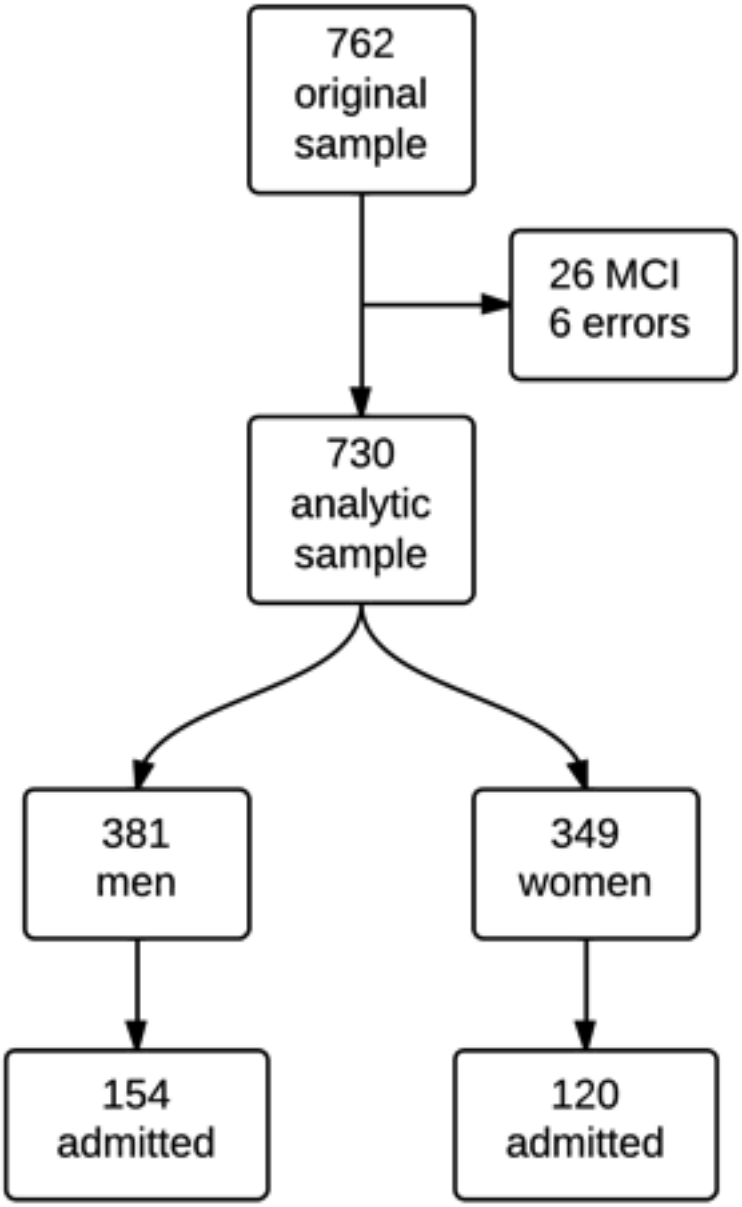

**FIGURE 2.** Kaplan-Meier curves for time to general hospital admission in people with dementia stratified by NPI score: longitudinal analysis of 730 men and women from the Scottish Dementia Research Interest Register

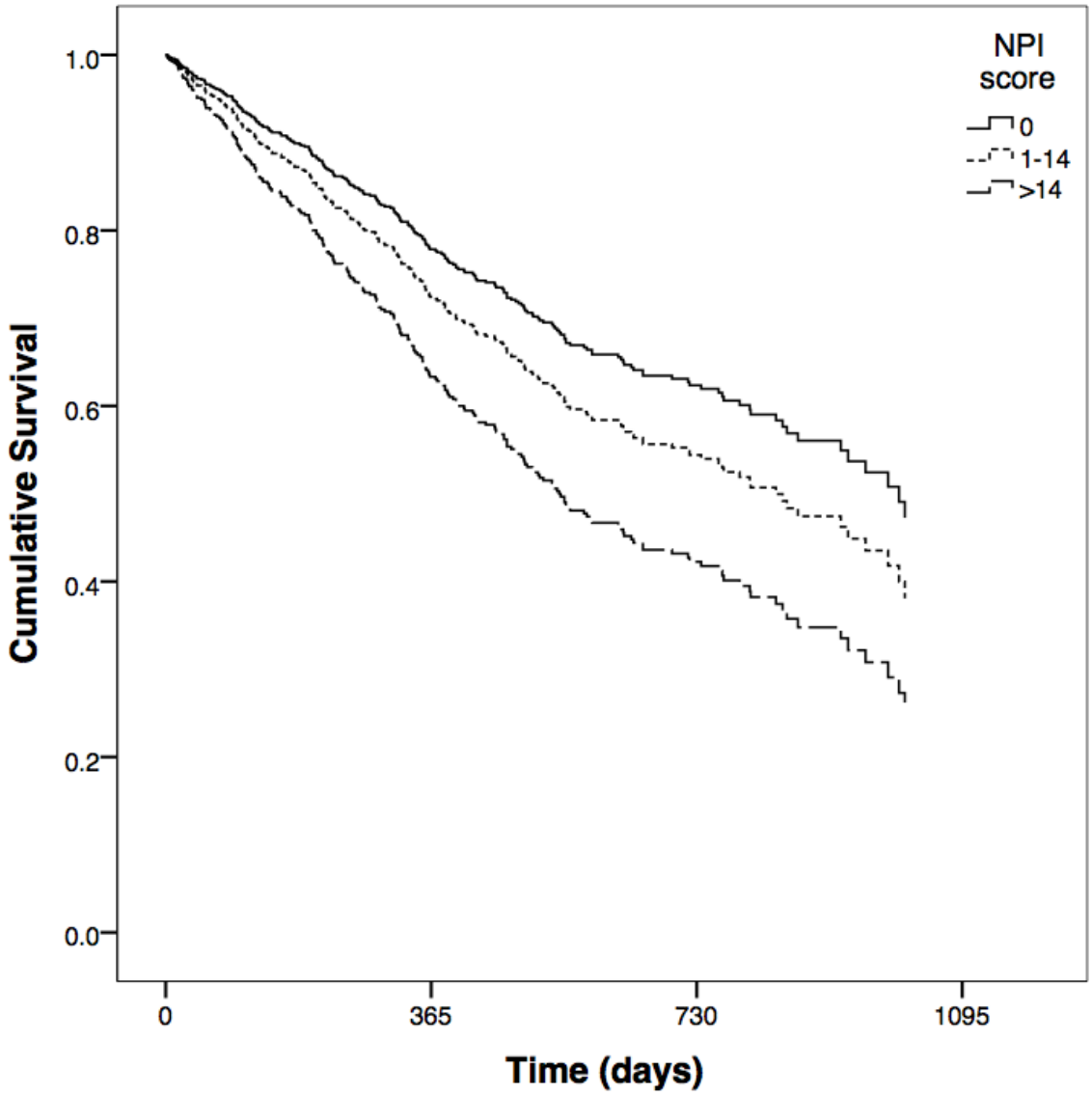

**TABLE 1.** Baseline characteristics of study participants according to whether or not an individual was admitted to hospital: longitudinal analysis of 730 men and women from the Scottish Dementia Research Interest Register

| | | Admitted to hospital | Not admitted | P | Total N with data for this variable |
|---|---|---|---|---|---|
| N | | 274 | 456 | - | 730 |
| Years of follow-up | mean (SD) | 0.8 (0.6) | 1.4 (0.8) | <0.001 | 730 |
| | maximum | 2.8 | 3.3 | | |
| Age | mean (SD) | 76.5 (8.1) | 76.1 (8.3) | 0.51 | 730 |
| | range | 52-94 | 50-93) | | |
| Female | N (%) | 120 (43.8) | 229 (50.2) | 0.09 | 730 |
| Diagnosis | N (%) | | | 0.66 | 730 |
| | *Early onset AD* | 25 (9.1) | 49 (10.7) | | |
| | *Late onset AD* | 155 (56.6) | 264 (57.9) | | |
| | *Mixed* | 38 (13.9) | 70 (15.4) | | |
| | *Vascular* | 32 (11.7) | 47 (10.3) | | |
| | *Other*[1] | 34 (12.4) | 26 (5.7) | | |
| Vascular risk factors[2] | N (%) | 140 (51.1) | 236 (51.8) | 0.03 | 730 |
| Any comorbidity[3] | N (%) | 175 (63.9) | 228 (50.0) | <0.001 | 730 |
| No carers | N (%) | 19 (6.9) | 29 (6.4) | 0.44 | 730 |
| Prescribed cholinesterase inhibitor | N (%) | 197 (71.9) | 347 (76.1) | 0.21 | 730 |
| Prescribed antipsychotic | N (%) | 14 (5.1) | 20 (4.4) | 0.65 | 730 |
| Prescribed potentially inappropriate medication[4] | N (%) | 25 (9.1) | 44 (9.6) | 0.81 | 730 |
| Mini-mental state examination | mean (SD) | 21.3 (6.2) | 21.3 (5.9) | 0.94 | 686 |
| Instrumental Activities of Daily Living Scale | mean (SD) | 3.5 (2.3) | 3.7 (2.3) | 0.27 | 663 |
| Physical Self-Maintenance Scale | mean (SD) | 4.1 (2.0) | 4.3 (2.0) | 0.23 | 701 |
| Neuropsychiatric Inventory (total) | mean (SD) | 12.2 (15.7) | 10.9 (15.2) | 0.30 | 696 |
| Neuropsychiatric Inventory (carer distress) | mean (SD) | 6.4 (7.9) | 6.3 (8.0) | 0.87 | 696 |
| Clinical Dementia Rating Scale (overall rating) | N (%) | | | 0.09 | 699 |
| | 0 | 7 (2.7) | 18 (4.1) | | |
| | 0.5 | 104 (40.2) | 181 (41.1) | | |
| | 1 | 96 (37.1) | 165 (37.5) | | |
| | 2 | 45 (17.4) | 51 (11.6) | | |
| | 3 | 7 (2.7) | 25 (5.7) | | |
| Clinical Dementia Rating Scale (sum of values) | mean (SD) | 5.8 (3.8) | 5.7 (4.0) | 0.85 | 677 |

[1] 'Other dementia' comprises DLB, PDD, FTLD, and other (not specified)
[2] Vascular risk factors include hypertension, hypercholesterolaemia, diabetes and smoking
[3] Comorbidity includes cancer, respiratory disease, and diabetes
[4] Potentially inappropriate medication according to updated Beers criteria (Campanelli et al., 2012[22])

**TABLE 2.** Age- and sex-adjusted hazard ratios (95% confidence intervals) for the association between baseline characteristics and subsequent admission to hospital for any reason: longitudinal analysis of 730 men and women from the Scottish Dementia Research Interest Register

| | N hospitalised | N total | HR (95% CI) | P |
|---|---|---|---|---|
| *Diagnostic subtype* | | | | |
| AD vs all others | 274 | 730 | 0.86 (0.67, 1.11) | 0.24 |
| Mixed dementia vs all others | 274 | 730 | 0.86 (0.61, 1.22) | 0.41 |
| Vascular dementia vs all others | 274 | 730 | 1.21 (0.84, 1.75) | 0.31 |
| 'Other dementia'[1] vs all others | 274 | 730 | 1.67 (1.09, 2.56) | 0.02 |
| Vascular risk factors[2] | 274 | 730 | 1.03 (0.81, 1.30) | 0.82 |
| Any comorbidity[3] | 274 | 730 | 1.28 (1.00, 1.65) | 0.05 |
| Having any carers vs none | 274 | 730 | 1.03 (0.64, 1.64) | 0.91 |
| Prescribed cholinesterase inhibitor | 274 | 730 | 0.87 (0.67, 1.14) | 0.32 |
| Prescribed antipsychotic | 274 | 730 | 1.32 (0.77, 2.27) | 0.31 |
| Prescribed potentially inappropriate medication[4] | 274 | 730 | 1.24 (0.82, 1.88) | 0.30 |
| Mini-mental state examination[5] | 263 | 686 | 1.00 (0.88, 1.14) | 0.97 |
| Instrumental Activities of Daily Living Scale[5] | 235 | 663 | 1.08 (0.95, 1.22) | 0.26 |
| Physical Self-Maintenance Scale[5] | 259 | 701 | 1.18 (1.04, 1.33) | 0.01 |
| Neuropsychiatric Inventory[5] (total) | 257 | 696 | 1.22 (1.09, 1.37) | <0.001 |
| Neuropsychiatric Inventory[5] (carer distress) | 257 | 696 | 1.14 (1.02, 1.28) | 0.03 |
| Clinical Dementia Rating Scale (overall rating) | 259 | 699 | | 0.45 (for trend) |
| 1 vs 0/0.5 | | | 1.06 (0.81, 1.40) | |
| 2/3 vs 0/0.5 | | | 1.24 (0.89, 1.72) | |
| Clinical Dementia Rating Scale[5] (sum of values) | 251 | 677 | 1.04 (0.92, 1.17) | 0.57 |

[1] 'Other dementia' comprises DLB, PDD, FTLD, and other (not specified)
[2] Vascular risk factors include hypertension, hypercholesterolaemia, diabetes and smoking
[3] Comorbidity includes cancer, respiratory disease, and diabetes
[4] Potentially inappropriate medication according to updated Beers criteria (Campanelli et al., 2012[22])
[5] Standardised so that hazard ratio is per standard deviation disadvantage